

Figs. 6 and 7 show the temperatures obtained from figs. 4 and 5 plotted on the thermograph records which are obtained daily at the observatory. This shows at a glance the character of the deviations. The mountain temperatures can be obtained from the plot which is marked by the dots at the hour intervals. Fig. 9 is interesting as showing a series of warm waves of about 5-hour period, which is followed by fig. 10, showing waves of about 1-hour period, the temperature finally settling down to a steady negative difference the following day.

Elsewhere we have published a larger number of traces,¹ but the examples we give here illustrate what we are obtaining from our mountain records. It is very much to be desired that similar traces should be obtained at other stations for comparison. The question of how far the results we have obtained are due to any peculiarity of our location has yet to be settled.

Mount Royal is one of the Montereian hills, of which there are several, all of volcanic origin, which rise above a very flat country. The nearest of these hills is Mount St. Bruno, 14 miles to the east, with an elevation of 560 feet. Beloeil Mountain comes next, about 24 miles from Montreal, but is considerably higher, about 1400 feet.

We desire some time to erect a thermometer on the summit of one of the higher mountains, such as Beloeil, but lack of funds renders this out of the question at the present moment.

The observations which have been made by Prof. J. E. Church, jr.,² on the summit of Mount Rose, to which our attention was directed by Professor Abbe during the past summer, seem to indicate similar advance changes. The observations are exceedingly difficult to obtain, and the heroic efforts of Professor Church to establish the Mount Rose Weather Observatory are vividly described in his interesting paper. The altitude of Mount Rose is 10,800 feet, vastly greater than the altitude of our high-level instrument, but the character of the mountain is that of a peak rising by itself, isolated from other land masses, similar to our more modest Mount Royal. Professor Church has compared the thermograph records obtained on the summit with similar records obtained at Reno, 6268 feet below, and finds advance times of warning for temperature changes at the lower level. Thus at noon on May 14 a period of low temperature set in on the mountain top thirty-six hours before the first appearance of frost in the adjacent valley. The time interval for a depression of temperature on Mount Rose to reach the region below at Reno is placed at from twenty-four to thirty-six hours. The time interval of warning which we have observed is shorter than that noted by Professor Church, but this is no doubt due to the very great difference in the altitudes of the respective stations. In one case it was observed that a gale of 40 miles per hour was met by the observer on the mountain top six hours in advance of its arrival at Reno. Here the high wind seems to have lessened the time of warning for the storm, just as we have found that a high wind with cold lessens the interval of the temperature fall at the lower station.

Should the time interval of warning be a question of altitude, as indicated by a comparison of Professor Church's results and our own, it would be of great interest as indicating the height at which meteorological changes have their origin. Simultaneous observations of temperature at different altitudes would thus be most instructive, when obtained on a recording apparatus such as ours placed at a low-level station. We believe that the complete success of this method of temperature forecasting depends on knowing at once the difference of temperature between the high and low levels. Thus several such arrangements would give at any moment the temperatures at various altitudes compared with a common level.

COLLAPSE OF A HOLLOW LIGHTNING ROD.

In *Nature*, London, July 5, 1906, page 230, Prof. J. A. Pollock, of the University of Sydney, N. S. W., describes a lightning stroke passing down a hollow rod used as a lightning conductor, and crushing it inwards. As the copper was about one millimeter thick considerable force would be required to do this, but as the diameter of the rod is not given nothing more definite can be stated as to the necessary pressure.

It is well known that a lightning flash involves the sudden expansion of the air in the direct line of discharge, thus producing an explosive effect, which is doubtless the origin of the thunder.

The intensity of this effect may be greatly reinforced by the sudden conversion into vapor of any masses of water or other liquid that may lie in the path. In this way the bursting asunder of the limbs and bodies of trees and the boring of trenches in the ground is explained.

The collapse of the copper tubular conductor is attributed by Professor Pollock to compression produced by the electrodynamic action of the current when the tube was hot and plastic. An equally plausible explanation is offered by Dr. Irving Langmuir of New York, who has been investigating the dissociation of gases and vapors around highly heated wires, as set forth in the following letter of August 22.

In reply to your letter of August 18, I would say that it is not possible that the dissociation of water vapor on the surface of a hollow lightning rod could account for pressures sufficient to make the rod collapse. At the melting point of copper (1084° C.) the dissociation of water vapor under atmospheric pressure is only 0.005 per cent and even at the melting point of platinum (1710° C.) it is less than 1 per cent. Under higher pressure the dissociation is still less. Furthermore the dissociation, even if complete, would increase the pressure only 50 per cent—a small amount compared to the pressure due to the heating of the gases around the rod.

I would suggest as an explanation of the phenomenon the practically instantaneous (explosive) vaporization of a layer of water on the outside surface of the tubular rod. Even a thin film, if converted rapidly enough into steam, could produce very great pressure.

Even without the presence of a film of water the pressure might be produced by the explosive expansion of the air near the outer surface of the rod. It is probable that the air inside the tube would not be heated so rapidly or to such a high temperature as the air outside the tube, because the current thru the rod, being oscillatory, would practically be confined to the outer layers.

In a later letter, dated September 18, Doctor Langmuir remarks:

Professor Pollock's explanation is interesting. * * * I do not know whether he made any calculation to see whether the electromagnetic forces would be of the order of magnitude required to crush a copper tube. The problem interested me, so I endeavored to make such a calculation. According to Poekel, W. Kohlrausch, and L. Weber the current in a lightning discharge is, on the average, 10,000 amperes, with a maximum value of 20,000 amperes. Taking this last figure as the basis for the calculation, and assuming the outside diameter of the rod to be 1 centimeter and the inside diameter 0.8 centimeter, I find that the electromagnetic force on the outside of the tube would be equivalent to a pressure of 42 pounds per square inch. This would cause compressive stresses in the tube of 210 pounds per square inch. This is calculated on the assumption that the current flows uniformly thruout the cross section of the copper of the tube. If the current is limited to the outside layers, because of its oscillatory character, the pressure would be about 14 per cent less.

A similar calculation, worked out for the case that the outer diameter is 0.4 centimeter and the inner diameter 0.2 centimeter, gives for the pressure 330 pounds per square inch, and for the stress in the copper 670 pounds per square inch. With an oscillatory current the pressures would be about 35 per cent less than these.

It hardly seems probable that such small pressures lasting for such a very short time as that during which the discharge lasts could produce the collapse of the rod. Copper does not become very soft when heated below its melting point, so we would not expect it to yield to pressure of such small magnitude. * * *

Of course the data on which the above calculations are based are too uncertain, and the results come out too nearly of the order of magnitude necessary for the crushing of the rod, to enable one to prove conclusively that the electromagnetic force is not the cause of the collapse. The pressure is proportional to the square of the current, so that a current of 40,000 amperes would produce four times the effects calculated above.

¹ Trans. Roy. Soc. Can., vol. 10, pp. 71-121 (1904), and vol. 12 (1906).

² Monthly Weather Review, June, 1906, Vol. XXXIV, p. 255.